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THE STAR CLUSTER IN URSA MAJOR

BY R. M. PETRIE

THE conspicuous group of seven bright stars in the constellation Ursa Major, the Great Bear, is a familiar sight to all who live in northern latitudes. Ursa Major is often known as the "Dipper" or the "Plough" or the "Wagon"[1] but, whatever the name, it is an object of admiration as it wheels in its great arc around the north celestial pole. To add to its charms it is visible every clear night of the year from all parts of the earth north of latitude 35° N. It is such a "landmark" to the student of the constellations that most guides assume that it is known to the reader who may proceed then to identify other groups. Ursa Major was one of the star groups to attract the attention of primitive societies and it is immortalized in the earliest legends and mythologies of the sky.[2]

The bright stars of Ursa Major attracted the attention of astronomers as soon as they acquired the means to measure the positions of stars with some accuracy.* A reason for scientific interest in the group was soon found with the discovery by Proctor in 1869 that five of the seven bright stars had a common apparent motion across the sky, moving together like a flight of birds. This phenomenon is shown magnified in figure 1. There was thus discovered a physical connection between these five stars, much more significant than the accidental formation of a spectacular group in the sky. Some years after Proctor's discovery the labours of a generation of positional astronomers revealed that a number of fainter stars, near Ursa Major, shared in the motion of the brighter stars and were undoubtedly connected with them. Final proof was supplied by the

*The wide visual pair *Mizar* and *Alcor* in the "handle" of the Dipper was used for centuries as a test of eyesight. Imagine the delight of astronomers to find that *Mizar* itself was a beautiful telescopic double, the first to be discovered. The fascination was increased when, in 1889, it was found that the brighter component of *Mizar* showed two sets of spectral lines, proving that it was a spectroscopic binary. This was the first spectroscopic binary to be discovered.

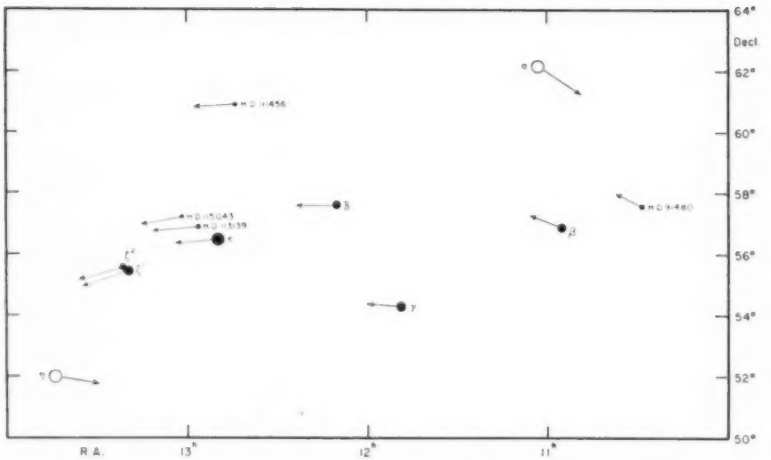

FIG. 1—The Stars of the Ursa Major Cluster. The arrows represent the apparent motion in 50,000 years. Note the prominent stars, α and η, whose motions show that they are not members of the cluster.

spectroscope in 1909, when it demonstrated that the stars also had equal motions in the line-of-sight direction as well as across the sky and that they therefore had a common motion through space. A group of stars so related is known as a moving cluster.

For a time astronomers continued to add to the membership of the group, mostly on the basis of apparent motions across the sky, until nearly one hundred stars were included. However, a careful review, especially of the line-of-sight motions,[3] showed that most of the candidates shared only approximately in the motion of the five bright stars and could not legitimately qualify for membership. A residual "nucleus" or true moving cluster is now recognized as including only eleven stars, all in the environs of the constellation. It is possible that more members will be found among the fainter stars in that part of the sky, but a careful search has, so far, failed to increase the number. The Ursa Major cluster has been the subject of spectroscopic study at Victoria during recent years, and this account is prepared to acquaint the JOURNAL's readers with some of the modern results and knowledge of this famous group.

The study of moving clusters is of considerable value to astronomy, supplying us with reliable measures of the true brightness of stars. This allows us to calculate their sizes and to make estimates of their mean densities. The information is also important because it helps us to study

with some precision the fundamental relation between intrinsic brightness and spectral type, or surface temperature. It will be shown later that the distance to a cluster may be measured with some accuracy from dynamical considerations. It is this knowledge which is so important, for direct distance measures are difficult to make and are usually subject to serious uncertainties. Clusters are of interest also in studies of stellar dynamics and the nature of the galaxy. The motions tell us something of the forces prevailing in the galaxy and of the role played by stellar encounters in determining the motions of the stars.

When the apparent motions of the members of a cluster across the sky (proper motions) are measured, it is found that they lie along arcs that, if produced, would intersect at some place on the celestial sphere. This effect is, of course, a consequence of the parallelism of the space motions. If the group has some motion toward us, the individual stars appear to be diverging from the intersection of the proper motion arcs; if the motion is away from us the stars appear to be converging upon the common point. The place in the sky where the apparent motions intersect is called the *convergent*, which tells us the direction of the space motion of the cluster.

Figure 2 will show how the distance and space motion of a cluster may be found from the observed motions of the individual stars. The observed motions are: first, the apparent motion across the sky, called

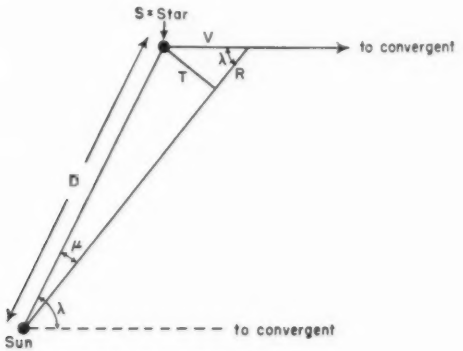

FIG. 2

proper motion, measured in seconds of arc per year; and, second, the speed of approach or recession called *radial velocity*, measured with the spectroscope directly in kilometres per second. A cluster star is shown at S moving in the direction indicated. This direction is that of the con-

vergent to be found from a consideration of the proper motions of all the members. If the space motion is V, the radial and tangential velocities R and T are seen to be

$$R = V \cos\lambda$$
$$T = V \sin\lambda$$

where λ is the angle, on the sky, between the star and convergent point. We may also write

$$D = T/4.74\mu = V \sin\lambda/4.74\mu = R \tan\lambda/4.74\mu$$

where D is the distance to the star (in appropriate units) and μ is the observed proper motion. Thus the distance may be found from the observed motions only and will be more accurately found from them than from direct measures of distance.

The determination of the convergent point is not always easy. If a cluster has a large radial motion, the individual member stars will appear to converge to, or diverge from, a nearby place in the sky and any one of several methods will fix this point with all necessary precision. An example of this is given by the Taurus cluster[4] where the convergence of the proper motions is quite apparent when plotted on a section of the sky. The Ursa Major cluster, however, is far removed from its convergent point and the problem is more difficult. A glance at figure 1 will convince one that a common point to the proper motion arcs is anything but apparent. The problem has been given some consideration at the Dominion Astrophysical Observatory, and recently, with the aid of new and accurate motions supplied by the United States Naval Observatory, Dr. B. N. Moyls* and the writer were able to determine a convergent with satisfactory accuracy.[5] We found the convergent point, from the proper motions of the eleven stars, to be at right ascension $300^\circ \pm 2^\circ.2$, declination minus $32\frac{1}{2}^\circ \pm 2^\circ.1$, located on the eastern edge of the constellation Sagittarius. This point is about 130° from the stars in the "Dipper".

In addition to employing the proper motions the eleven stars were observed rather extensively at Victoria using a high-dispersion spectrograph. This was done to strengthen the existing material on the radial (line-of-sight) motions. The spectra of the bright Ursa Major stars are difficult to measure accurately because of the diffuse appearance of the spectral lines and thus a considerable number of spectrograms was required to yield reliable velocities. With the data given above and with the new radial velocities it was possible to calculate the distances and derive the luminosities of the members of the cluster. The common space motion was determined as 15.2 km./sec. $\pm$ 0.8 with respect to the sun

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and in the direction of the convergent. The distance to the group, calculated entirely from stellar motion observations, turns out to be seventy-five light-years. The Ursa Major cluster is thus the moving cluster nearest to us.

Having found the distance and space motion we may calculate the luminosities, the spatial positions, and other interesting data for each of the members. Some of this material is shown in the table which gives, in addition, the fundamental observational material in columns two to six. The annual proper motion and its direction are listed in columns four and five, the radial velocity in column six, then follow the luminosity and radius of each star, in terms of the sun, and finally the distance of each star, in light-years, from the approximate centre of the cluster.

THE STARS OF THE URSA MAJOR CLUSTER

Star	Apparent Magnitude	Type	Proper Motion	Direction of Proper Motion	Radial Velocity	Luminosity ⊙ = 1	Radius ⊙ = 1	Distance from Centre
			per yr.		km./sec.			l.y.
H.D. 91480	5.2	A8	0.078	64°	− 10.4	4	1.2	23
β UMaj	2.4	A0	0.090	71	− 12.2	48	2.7	18
γ UMaj	2.5	A0	0.096	86	− 13.5	46	2.6	10
δ UMaj	3.4	A0	0.105	88	− 16.5	48	2.7	3
H.D. 111456	5.9	F5	0.109	90	− 9.1	2	1.3	10
ε UMaj	1.7	A0	0.114	96	− 7.4	91	3.7	7
H.D. 113139	4.9	A4	0.121	96	− 8.7	4	1.0	8
H.D. 115043	6.7	G0	0.113	100	− 8.3	1	1.1	11
ζ^1 UMaj A	2.4	A2	0.123	105	− 8.2	44	2.8	12
ζ^1 UMaj B	4.0	A8	0.123	105	− 8.2	10	2.0	12
ζ^2 UMaj	4.0	A3	0.120	103	− 12.4	11	1.5	13

The luminosities (in terms of the sun) are shown in relation to spectral type in figure 3. It is seen that there is a very rapid decrease in brightness as the spectral type changes from A0 to G0 (falling surface temperature). The hottest stars are nearly one hundred times as bright as the sun, while

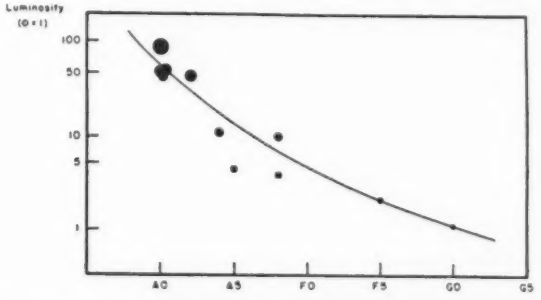

FIG. 3—The Luminosities and Spectral Types of the Cluster Stars.

the coolest member, H.D. 115043, is the same luminosity as the sun. The relation shown in figure 3 is part of a general phenomenon of profound importance in studies of stellar evolution and stellar populations. One can see how part of this relation has been defined by the Ursa Major cluster stars and how useful the moving clusters can be in studying this important matter.

The shape of the cluster is shown in figure 4, where the positions are plotted on the plane which lies quite close to all the members. The individual stars are scattered along a line in this plane approximately parallel to the plane of the galaxy. The motion of the group is in the direction marked by the arrow and at an angle of about thirty degrees to the plane of the paper, toward the reader.

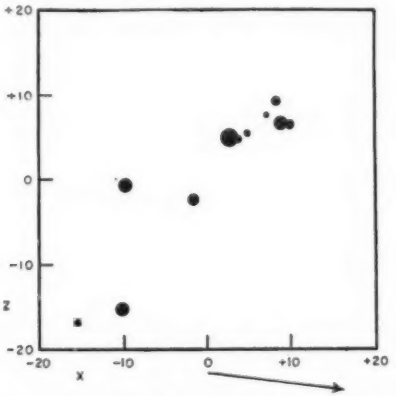

FIG. 4—The Space Distribution of the Stars of the Ursa Major Cluster. The units are light-years.

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   Charles' wain is over the new chimney, ..." (Henry IV, Part 1)
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Dominion Astrophysical Observatory,
Victoria, B.C.
April 1953.

THE DISCOVERY AND INTERPRETATION OF NICKEL-IRON GRANULES ASSOCIATED WITH METEORITE CRATERS

By Lincoln LaPaz*

Introduction: All meteoriticists appreciate the contribution made to their science by F. K. Dalton through his systematic studies of the microhardness of meteorites as determined by means of the Knoop diamond indenter.[1] However, I should like to point out that H. H. Nininger's recent gathering of nickel-iron granules at the great Arizona crater is not a new "epochal discovery" as Dalton terms it.[2] Indeed the discovery actually was first made, nearly half a century ago, by the pioneer investigators of the crater, D. M. Barringer[3] and B. C. Tilghman,[4] whose findings were confirmed by later systematic studies at this crater. Tilghman, in particular, as early as 1905 estimated that the metallic nickel-iron granules which he recovered by use of a magnetic separator from samples taken from the north and south slopes of the crater, as well as from the filling inside this crater, occurred in the proportion of 1/80 to 1/4 oz. to the ton, results in line with modern determinations of the *average* concentration of these granules.

Again, no novelty can be claimed for the idea that the impact of high-velocity meteorites with the earth develops such intense heat as to fuse and partially vaporize great quantities of both projectile and target material and to eject the resulting *mélange* from the impact crater and widely scatter the heterogeneous debris. Precisely these conceptions are carefully discussed in G. P. Merrill's classical paper of 1908 on the Barringer Meteorite Crater.[5] In fact, in concluding his paper Merrill suggested that the failure of Barringer and Tilghman and their associates to find the so-called "main mass" of the meteorite might result from its volatilization by the intense heat generated when it struck the earth.

Furthermore, a score of years ago, the discovery of globules of nickel-iron at the Henbury and Wabar meteorite craters was reported in a classical paper written by L. J. Spencer,[6] the dean of English meteoriticists. Spencer, as early as 1933, correctly attributed not only the millions of tiny spheres of shining metallic nickel-iron found chiefly in the very widely distributed silica glasses of Wabar and Henbury, but also the small, roughly globular "crinkled peas" collected in the Henbury vicinity to a "rain" of molten metal condensed from the vapours of the siderites whose impacts produced the craters in these localities.

*Director, Institute of Meteoritics, University of New Mexico.

Finally, photomicrographs of etched sections of spheres of nickel-iron from Wabar taken by J. M. Robertson of the Royal School of Mines were given in Spencer's paper together with a report by Robertson indicating that the observed micro-structure corresponded to what would be obtained by "the rapid cooling of an iron-nickel alloy containing Ni 4-9%." This micro-structure is correctly described as "martensitic" not as Widmanstätten.

Since there seems to be general unfamiliarity with the literature just referred to and since the earlier publications in this field are now difficult to obtain, even in the United States, I give below the essential portions of the papers which refer to these nickel-iron granules.

I. Meteoritic Granules at the Barringer Meteorite Crater in Arizona

. . . . . the surface of the surrounding country for perhaps several miles, concentrically around the crater, contains minute particles of this iron shale either in the shape of fragments or as *spherules*. It is found everywhere in the vicinity of the crater, on the rim and on the outside plain.–*Barringer*, p. 877.

. . . . . some pieces of iron shale have been found adhering to small fragments of limestone and sandstone, or in one small specimen which I found including them, showing conclusively that this iron oxide was in a *liquid* or *fused* state when it fell to earth.–*Barringer*, p. 882–3.

. . . . . as no meteoric material except nickel-iron and magnetite containing nickel had been found in the vicinity . . . . a search for this material was made with *magnets* about the locality and it was found that its presence was absolutely universal over the whole locality inside the hole and out for as far as observed, somewhat over two miles from the hole. . . . . Of very rare occurrence among it are absolutely round balls with a fused polished surface like intensely fine shot. These, it is supposed, have had time to solidify in the vacuum behind the flying meteor free from the fierce rush of air that had solidified the usual grain in any shape whatever, and they were enabled thus to assume the usual shape of liquid drops.–*Tilghman*, p. 898.

. . . . . there has been found among the filling material in a few localities, but much more sparingly than the magnetite or silicate of iron, small round globules of *metallic* iron surrounded by an envelope of magnetite. These small globules range from one-twenty-fifth to one-fiftieth or an inch in diameter.–*Tilghman*, p. 906.

Since this article was written, the author has discovered the presence of a small amount of very finely divided *metallic* iron among the silica. This has been found, so far, in every sample examined, from the north and south rims as well as from the filling of the central plain. It varies in amount, but its proportion is extremely small. The largest amount has been found among the silica from the filling of the crater, where it exists to the proportion of nearly a quarter of an ounce to the ton. From the north and south rims the amount is less in the order stated; from the south rim it does not amount to a twentieth as much as from the interior of the crater.

This metallic iron was detected, separated and estimated as follows: The silica was passed through a magnetic separator and a very small amount of magnetic material of a dark color collected and weighed. A weighed portion of this was care-

fully ground in an agate mortar, wet and the finely powdered material washed away from time to time until the material was reduced to about one-tenth of its original bulk. In this residue, by the use of a glass, could be observed a great number of bright, white, shining metallic scales and spangles. They were strongly influenced by a magnet. A solution of copper sulphate was then poured over this residue and the bright white spangles were observed to turn dull red-copper color at once. The finer portions were then observed to be indifferent to the magnet, although the larger ones were still attracted. On prolonged treatment all became indifferent to the magnet. The residue was then washed and the copper in it determined, there being none in it before treatment. As a check the iron was determined in the copper sulphate solution used and wash waters, the solution being pure. Distinct traces of nickel were also observed in this material.–*Tilghman*, p. 907 (footnote)

We have, however, unquestionable proof of a force of impact sufficient to crush a mass of limestone 300 feet in thickness, ... and of sandstone 500 feet in thickness . . . . . , and this, too, with a production of heat equivalent to the 3,900° or fusing point of quartz above noted.–*Merrill*, p. 494.

The heat generated . . . . would produce fusion and probably a partial volatilization and where sufficient moisture was present, other conditions being favorable, would give rise to the pumiceous structure found in the altered sandstone. . . . . The effect of the impact would be to convert almost instantly this moisture into steam with an enormous explosive power. As a result quantities . . . of debris, including even portions of the meteoric fall itself would be ejected and thrown back above the crater rim and scattered widely over the plain. It would seemingly be safe to assume a temporary pseudovolcanic condition.–*Merrill*, p. 495

The failure thus far to find a large intact mass within the crater might be further explained on the ground that a considerable portion of it was volatilized by the intense heat generated at the moment of striking the surface, and the comparatively small residual remaining has largely succumbed to oxidation.–*Merrill*, p. 496

II. Meteoritic Granules at the Wabar and Henbury Meteorite Craters

Silica-glass is very abundant at Wabar. Mr. Philby's photographs of the craters show the cindery masses thickly strewn over the surface of the ground; and the walls of the meteorite craters here appear to be built entirely of this material. . . . . In micro-sections the Wabar silica glass shows . . . . . numerous small black spots . . . . . ranging from 0.14 down to 0.003 mm. in diameter, and further to mere dust. These black spots show a metallic lustre by reflected light, but the idea that they could be metal appeared at first to be so improbable that they were thought to represent small bubbles filled with the grinding powder used in the preparation of the section. When, however, a fragment of the glass was crushed in oil on a microscope slide, it was seen that these small spots became isolated. A small piece of the glass was crushed (not ground) in an agate mortar, and spheres were then picked out from the powder with a magnetic needle, to which they adhere in long strings and clusters by the thousand. The spheres readily break away from the glass, but minute fragments of glass still enclosing a sphere are also attracted. They are perfectly spherical with a highly polished steel-grey surface. In a solution of copper sulphate, copper is deposited on their surface.–*Spencer*, p. 394–5

At Henbury the silica-glass is much less abundant and is less obvious . . . . . In micro-sections the Henbury glass is dark brown and . . . . . only few black spots are seen, and very few metallic spheres were extracted by a magnetic needle from the powdered material.—*Spencer*, p. 396–7.

The presence in this black glass of iron and nickel in about the same ratio as in the meteoric iron proves that a part of the meteorite was also vaporized. The millions of tiny spheres of nickel-iron enclosed in the silica-glass represent a rain, or rather drizzle, of molten metal, condensed from iron and nickel vapours. The fact that these spheres are intimately intermixed with the vesicular silica-glass suggests that this rain fell into a pool of boiling silica. Some of them no doubt also represent drops of molten metal from the meteorite incorporated in the silica-glass (as seen in slags from metal furnaces); but no larger globules of metal were found.—*Spencer*, p. 399.

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COMMUNICATIONS
FROM THE
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AN OSCILLOSCOPIC MICROPHOTOMETER FOR USE WITH ASTRONOMICAL SPECTROGRAMS*

By William R. Hossack

Introduction

This is an account of an instrument which has been designed and constructed at the David Dunlap Observatory for the purpose of studying spectrograms taken with the one-prism spectrograph of this Observatory.

A part of a stellar spectrogram is shown as a positive print in figure 1a; the central part is the spectrum of a star; the outer parts that of the iron comparison spectrum. To study the intensities of the lines appearing in

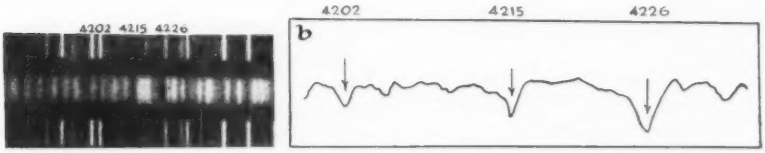

Fig. 1 (a)—Positive of a portion of a spectrogram. The central spectrum is that of a K0 type star.
(b)—Microphotometer tracing of the stellar spectrum shown in (a).

the stellar spectrum, a registering microphotometer is commonly employed to produce a tracing of the density in the photograph, as illustrated in figure 1b. The new instrument is a microphotometer in the sense that it also produces such a tracing, but, although it is admittedly not capable of the same degree of precision, it goes further than the conventional microphotometer in several ways, and is thus a more versatile instrument. In the first place it produces its tracings instantaneously on an oscilloscope screen rather than by a slow recording process on a paper

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The author is indebted to the Research Council of Ontario for a scholarship in connection with this research.

strip, so that it lends itself to more rapid examination of the spectrograms. In the second place it produces tracings of two stellar spectra at the same time so that they may be compared as to the relative intensities of certain lines for such purposes as spectral classification. In the third place the instrument produces in addition, if desired, tracings of the comparison spectra, and this makes it possible to measure relative positions of the lines in the two stellar spectra. These points are illustrated in figure 2 which is a photograph of the presentation of both stellar and comparison spectra on the oscilloscope screen.

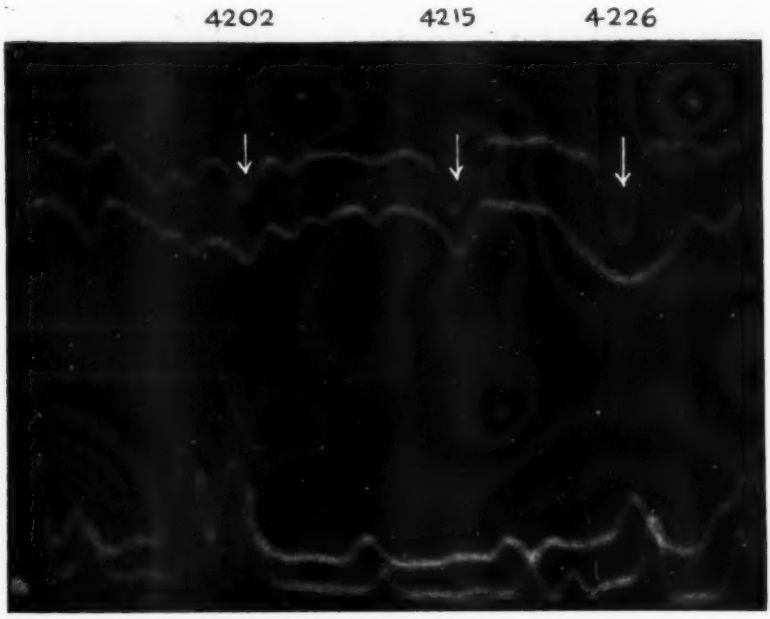

FIG. 2–Photograph of the oscilloscope screen. *Top trace*– K0 type spectrum (compare with figure 1). *Second trace*– K5 type spectrum. *Bottom traces*– Corresponding iron arc comparison spectra. The displacement of the comparison spectra indicates a difference in radial velocity between the two stars amounting to 80 km./sec.

MECHANICAL AND OPTICAL DESIGN

The new type of microphotometer owes its ability to examine two spectrograms simultaneously to the fact that it is built around a Hartmann Spectro-comparator.[1] This is an instrument which enables the user

1. Plaskett, J. S., Canada, Report of the Chief Astronomer for 1909, p. 177.

to view both stellar and comparison spectra of two spectrograms in the same eyepiece, and to adjust the magnifications of the spectrograms so that the two can be matched precisely.

Whereas the Hartmann Spectro-comparator presents a visual display of the two stellar and comparison spectra, the new instrument presents, as we have seen, a photometric display. This has been achieved by converting the Hartmann Spectro-comparator into a projection device and sweeping the projected display of spectra past a photomultiplier tube which supplies voltages to an oscilloscope in such a way as to present a continuous display of the densities of the various parts of the spectrograms.

Figure 3 is a photograph of the mechanical and optical parts of the instrument. The oscilloscope and other electronic components are separate units and are not shown. Two spectrograms are placed in the comparator: one, a standard, in a fixed position *A*; the other, the plate to be measured, in a movable carriage *B*, the position of which can be determined from an accurate micrometer screw *C*. The projection system is built onto the underside of the comparator. Two beams originate from a projection bulb, one passing through each of the plates. Two prisms *D*

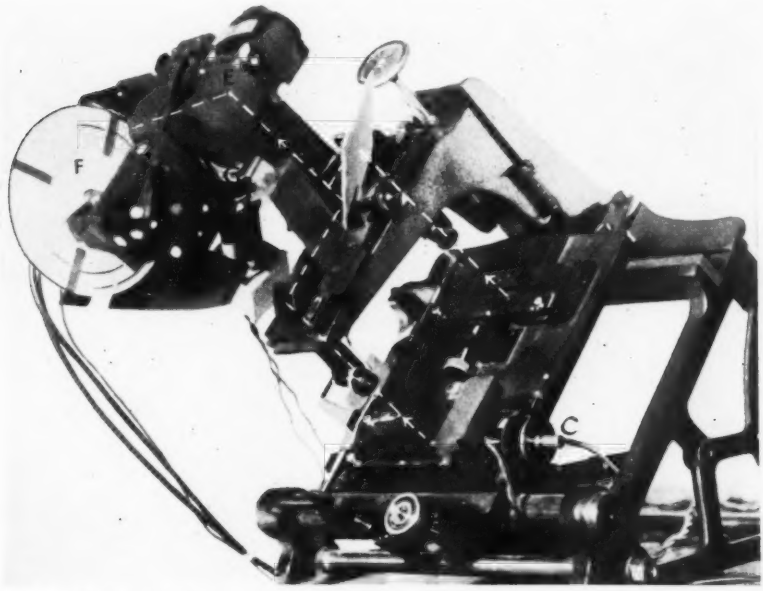

FIG. 3—Photograph of the mechanical and optical parts of the instrument.

bring them together, and an image is projected consisting of an array of two stellar spectra and their two iron arc comparison spectra. This array is shown in figure 4. Motion of the micrometer screw *C* will move the one spectrogram relative to the other in the array, in a direction along the lengths of the spectra.

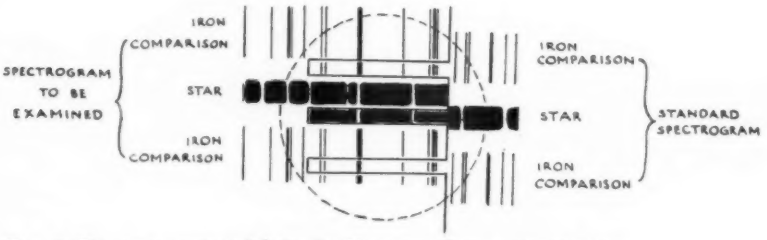

FIG. 4—The array projected from the Hartmann Spectro-comparator.

The principle involved in the presentation on the oscilloscope screen is as follows: A multiplier phototube produces a current or voltage proportional to the amount of light falling upon its photo-sensitive surface. If a slit opening is placed in front of it and the projected image of a spectrum moved past the slit, the voltage will drop and then rise again as a spectral line passes the slit. In fact the voltage output will be an indication of density along the spectrum as the spectrum is moved by. If the spectrum is moved by repeatedly in a periodic manner and the output voltage fed to an oscilloscope whose horizontal sweep is synchronous with the period, a curve very similar to the one of figure 1b will be seen on the oscilloscope screen.

The motion of the spectrum past the slit is provided by a mirror *E* rotating 60 times per second which repeatedly sweeps the array of figure 4 past a slit in front of a 1P21 multiplier phototube. In order that just one of the four spectra will pass through the slit at any one time, a slotted disk *F* rotates directly in front of the slit at quarter speed so as to mask out all but one of the spectra. A different spectrum is allowed through during each quarter cycle of the disk, or each time the array of figure 4 is swept past the slit. A cylindrical lens of very short focal length (1 cm.) is placed between the 1P21 phototube and the slit in order to keep the image stationary and spread it out over the photo-sensitive surface. The signals resulting from each of the spectra are separated out electronically and applied as the vertical signal to the oscilloscope.

It is necessary to have a synchronizing pulse to initiate the time base of the oscilloscope. A slit source originating at *G* is reflected from the rotating mirror *E* and reaches a slit in front of a separate phototube just

before each projected spectral image reaches the 1P21. The resultant pulse serves for synchronization, and is in the same relation to all spectra. This method precludes irregularities caused by vibration in the rotating mirror, since both the slit and spectral systems are subject to the same vibration.

Electronic Design

The signal patterns as they come from the 1P21 multiplier phototube appear as sketched in figure 5, except that distances between the patterns are much larger than indicated. The patterns are amplified and separated out in a manner which incorporates the following features:

(a) presentation on the oscilloscope screen in a vertical array as in figure 2,
(b) separate amplification and vertical-positioning controls for each trace,
(c) frequency response flat to 200,000 cycles/sec. for the narrowest spectral lines, since it takes just 1/200,000th of a second for one of these to be swept past the slit in front of the 1P21 multplier phototube,
(d) a linear time base,
(e) linear response in the amplifiers used for amplifying the vertical signal.

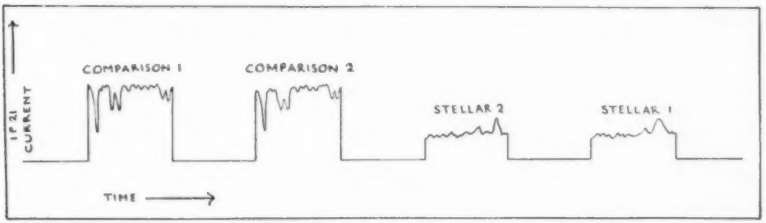

Fig. 5—Signal patterns from the 1P21 multiplier phototube.

The principle of the electronic circuit is best understood from the block diagram in figure 6. The sequence of signal patterns goes in parallel through four amplifiers which are "gated" so that each of them lets through a different one of the four signal patterns. Controls on these

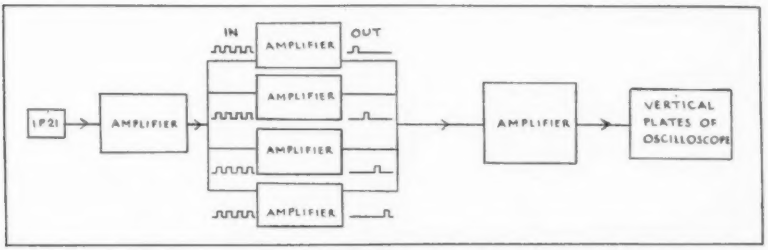

Fig. 6—Block diagram of the circuit. The signal patterns from the 1P21 are shown going into, and coming out of each of the four parallel amplifiers.

amplifiers make it possible to deal separately with each signal pattern. The outputs are joined together again before presentation on the oscilloscope screen. The oscilloscope is a single beam type and traces out the four patterns in order. Appearing on the screen are four traces like those of figure 2. The "gating" is done by means of a synchronized ring circuit which cuts the amplifiers on and off in a cyclic manner. Controls for adjusting the vertical positions of the traces separately are obtained by utilizing voltages from certain tubes in the ring circuit. Voltages are fed to the vertical plates of the oscilloscope to act as "pedestals", on top of which are added the varying signal patterns. The ring circuit is synchronized from the 60 cycle A.C., as is also the rotating mirror which sweeps the array of figure 4 past the slit in front of the 1P21 multiplier phototube.

The linearity of the vertical response was checked in two ways. Comparison of oscilloscopic traces with photographic microphotometer traces of the same plate, known to be linear, showed the agreement to be good. Relative depths of lines on the oscilloscope screen remained unchanged as the brightness of the projection bulb in the Hartmann was varied. Changing the brightness is equivalent to changing the level of the signal pattern, and would reveal any non-linearity. Square waves with which to check the frequency response were obtained directly from the optical system by putting slits and cross-hairs where the plates are normally placed on the Hartmann.

Radial Velocities

For purposes of measuring the positions of spectral lines it seems possible that the lining up of contours on an oscilloscope screen is more objective and involves less personal error than the centering of a cross-hair on a spectral line, particularly on a broad fuzzy one. The oscilloscopic microphotometer method of measuring radial velocities corresponds to the former, while the methods most widely employed at present correspond to the latter. In the application of the oscilloscopic microphotometer to radial-velocity measurement, the stellar spectra (see figure 2) are lined up in the wave-length co-ordinate by motion of the "movable" plate, and the micrometer screw reading noted. The iron arc comparison spectra are similarly lined up and this reading noted. The difference in the readings gives a measure of the displacement of the lines of the spectrum to be measured relative to those of a spectrum corresponding to a known radial velocity. The average wave-length over the spectral region presented in the array is used to reduce the displacement to km./sec. This is analagous to the method regularly employed in the visual Hartmann method.

Measures made with the oscilloscopic microphotometer were compared with visual measures made upon the ordinary measuring engines com-

monly employed for radial-velocity measurement. Measures of late (K0) type stars gave approximately twice as large an internal probable error using the oscilloscopic method, although the time required to obtain the plate velocity was just one half the time required in the visual method, namely thirty minutes compared to an hour. Measures of early (A0) type stars gave an internal error using the oscilloscopic method amounting to 0.7 of that obtained visually. The time required to obtain the plate velocity was about one third of the corresponding visual time. This accuracy is, however, not much better than that obtained using the visual Hartmann method on plates carefully matched as regards density.

The limitations of this oscilloscopic method probably lie in the fact that it is practically impossible to line up the plates in the Hartmann exactly as they should be. This is bound to introduce error.

Spectral Classification

The criteria for spectral classification of late-type spectra from moderate dispersion spectrograms are the relative intensities of certain absorption lines known to be particularly sensitive to temperature or luminosity effects. The instrument described here affords a method of measuring the relative intensities which is at the same time rapid and reasonably precise. For this purpose the traces of the comparison spectra might be dispensed with.

Let us say we wish a measure of the relative intensities of the lines at 4215A. and 4250A. It is not necessary to determine this absolutely; it may be referred to some "standard" spectrum, not unlike the ones to be examined. In what follows we refer to this as the "standard", and the spectrum to be examined as the "unknown". After some experimentation the following was found to be the simplest and best method for getting the relative intensities in terms of the relative intensities of the same pair of lines in the standard.

A scaled rheostat is in series with the projection bulb on the Hartmann. With the help of this aid, the light can be cut down by any amount, and the amount registered on the scale. At the beginning of a measurement, the light is subjected to the full voltage and the rheostat reads zero. Suppose that the 4215A. and 4250A. lines are to be compared. By means of the amplification controls, the spectra are set so that the 4215A. lines are of the same depth on the two traces. The 4250A. line appears to be of a certain depth on the trace of the standard. The 4250A. line on the unknown may be shallower, equal, or deeper. If it is deeper, the rheostat is used to cut down the light until the 4250A. line of the unknown reaches the depth on the screen that the 4250A. line of the standard had for full light. The reading of the rheostat is noted and termed positive. If the 4250A. lines are equal in depth, the reading or ratio is zero. If the 4250A.

line of the standard is the deeper, the light is cut down until it reaches the depth that the 4250A. line of the unknown had for full light. In this case, the reading is termed negative. It is not difficult to retain a mental picture of a line and its depth while the light is being cut down. Several settings of the rheostat are made and an average taken. Figure 7 serves to illustrate the method.

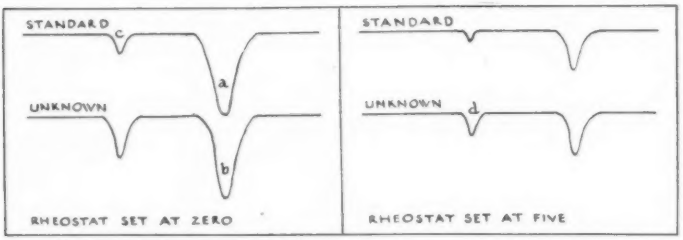

FIG. 7—Illustration of the method for obtaining relative line intensities. Contour *a* is equal in depth to contour *b*. Contour *c* is equal in depth to contour *d*.

The same standard is left in the microphotometer while readings are taken for many unknowns. A number is obtained for the ratio 4215/4250 for each unknown spectrum, and the scale of numbers will have the qualifications desired. The plate with which the unknowns are compared on the microphotometer need not be a classification standard, since it determines only the zero point of the scale. It is preferable to measure classification standards along with the unknowns and to calibrate the scale from the values which they give.

Many tests were made for reproducibility, using the same plate and different amplifier settings, and using different plates of the same star. These tests showed the method to be successful in this regard. Results regarding precision and speed of the actual spectral classification show real promise and are to be published in the near future. The method lends itself also to the systematic study of spectrum variables.

ACKNOWLEDGEMENTS

The author owes much to the late Dr. Frank S. Hogg, who initiated this research. He is grateful to Dr. J. F. Heard for his invaluable help and advice. The author's thanks are also due to Mr. G. F. Longworth who not only built, but designed many of the optical and mechanical parts. Stimulating discussion was had with Dr. J. M. Anderson of the Department of Physics of the University of Toronto, and with Mr. R. L. Baglow and Dr. R. E. Williamson, formerly members of the staff of the David Dunlap Observatory.

NATURALISTE HONORE PAR LA FONDATION MARIE-VICTORIN*

PAR ROLAND MARION†

LE 16 avril dernier, la Société canadienne d'Histoire naturelle clôturait une Exposition et un Congrès Internationaux de naturalistes au gymnase du Mont-Saint-Louis de Montréal. Au-delà de 75,000 visiteurs ont défilé devant les nombreux kiosques tandis que plus de 300 personnes suivaient les sessions du congrès. Dans toute son histoire, la S.C.H.N. vient de vivre les heures les plus glorieuses de sa vie. Pour tous les naturalistes, jeunes et moins jeunes, ces grandioses manifestations étaient le fruit du grain de sénevé mis en terre par le regretté frère Marie-Victorin, f.é.c., fondateur de cette société vingt-neuf ans auparavant.

Pour couronner ce congrès qui groupait les éducateurs à tous les degrés de l'enseignement ainsi que ceux qui se consacrent à l'éducation populaire, de salutaires résolutions étaient présentées par le président du comité nommé à cette fin. Et comme si le responsable de tout ce déploiement avait, de l'au-delà, voulu manifester sa joie, monsieur Jacques Rousseau, directeur du Jardin Botanique, annonçait ensuite la création d'une nouvelle décoration par la "Fondation Marie-Victorin", en plus de celle déjà existante pour les scientistes, cette fois pour honorer le naturaliste qui s'est distingué par ses travaux et son dévouement dans le domaine de la vulgarisation scientifique. En l'occurence, les deux premiers récipiendaires de cette nouvelle médaille furent Soeur Marie-Jean-Eudes, s.s.a., et monsieur J.-Edgar Guimont.

En gage d'hommage respectueux, nous nous permettons de brosser très succintement la biographie de notre ami M. J.-E. Guimont, nouveau récipiendaire, qui s'est toujours dépensé sans restriction pour populariser les sciences naturelles, spécialement l'astronomie et la géologie.

Origines

Monsieur Joseph-Edgar Guimont naquit le 17 mai 1892 à Cap St-Ignace dans le comté de Montmagny. De 1905 à 1910, notre récipiendaire fréquente le collège Sacré-Coeur de Longueuil (vieux collège). Là, il subit l'influence des frères Marie-Victorin et Rolland-Germain, f.é.c., qui plus tard feront rejaillir la renommée sur notre pays. Il est confrère de collège de Son Honneur M. Camilien Houde, aujourd'hui maire de Montréal. Il est aussi membre du cercle Lasalle de Longueuil (A.C.J.C.). Incontestablement, le frère Marie-Victorin découvre chez ce collégien une disposition marquée pour l'étude scientifique qu'il encouragera en dépit le l'incompréhension des parents de celui-ci. Durant son séjour à Longueuil, M. J.-E. Guimont trouve en la personne du frère Marie-Victorin un confident à qui révéler ses aspirations et ses ambitions dans la vie. Mieux que personne, il l'encourage en l'amenant herboriser avec lui. Dans ses excursions avec le frère, le fil de la conversation court sur les sujets les plus variés, mais toujours élevés. Pour répondre à son enthou-

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†Directeur des Cercles de Naturalistes Adultes.

siasme pour la science, le frère Marie-Victorin permet au jeune Guimont de l'accompagner souvent au laboratoire.

Naissance de l'astronomie

Le passage de la comète Halley en 1910 impressionne grandement notre adolescent de 18 ans sur l'immensité de l'univers et marque d'une façon décisive sa vocation pour l'astronomie. A partir de ce moment, tous ses loisirs seront consacrés à scruter le ciel pour lui dérober ses secrets. Davantage il maîtrise l'astronomie, davantage il cherche. Plus tard, toutes ses activités seront dirigées vers la vulgarisation de l'astronomie dans le grand public.

Ses activités

Dès le 31 mai 1915, il devient membre titulaire de la Société Astronomique de France et durant la même année il publie de nombreux articles dans la revue de la Société de Géographie de Québec. A la même époque, il commence une correspondance assidue avec Camille Flammarion qui se prolongera jusqu'en 1925, année de sa mort.

Le 12 décembre 1918, il devient membre du Royal Astronomical Society of Canada, centre anglais de Montréal. Coincidence providentielle, Mgr. C. P. Choquette de St-Hyacinthe, pionnier de l'astronomie populaire dans notre pays, lui sert de parrain pour la circonstance.

En reconnaissance de son magnifique travail et des observations qu'il lui transmet, la Société Astronomique de France le nomme membre perpétuel le 20 juin 1921.

Avec l'aide de quatre dévoués collègues, il fonde l'Institut Astronomique et Philosophique du Canada le 7 janvier 1926. Cette société, qui manifeste une belle vigueur, poursuit ses activités durant sept années consécutives.

En 1927, il alimente une chronique hebdomadaire sur l'astronomie dans le journal "Le Nord". Convaincu que trop peu des nôtres s'intéressent à cette science, il tente d'éveiller par tous les moyens la curiosité puis l'intérêt des siens pour l'astronomie.

Grâce à ses conseils et à son enthousiasme, il assiste M. Paul H. Nadeau, L. Sc., à fonder le Royal Astronomical Society of Canada, centre français de Québec, le 18 avril 1941.

De 1940 à 1945, il collabore largement aux "Propos Astronomiques" de M. De Lisle Garneau dans le journal "le Devoir". Occasionnellement, nombreux sont ses articles qui paraissent dans les publications ou journaux suivants: le bulletin "The Journal", organe du R.A.S.C.; le journal "L'Action Catholique" de Québec; les journaux "La Presse" et "La Patrie" de Montréal.

Le 7 décembre 1941, se fonde l'observatoire Ville-Marie à Montréal.

Toujours avec le même dynamisme, il en est le co-fondateur avec M. De Lisle Barneau. Il s'ensuit une collaboration étroite pendant les cinq années qui suivent.

Cherchant toujours un terrain pour déverser le trop-plein de son activité débordante, il fonde avec deux collègues, le 8 janvier 1945, le cercle de naturalistes adultes "Les Amis de la Nature". Par la suite, ce cercle devient le plus actif parmi les cercles de naturalistes adultes. Sous les auspices de ce cercle, il organise, le 16 juillet 1945, la première soirée astronomique publique chez les canadiens-français de Montréal. Soirée réussie à tous ponts de vue qui attire plus de 3,000 personnes sur les terrains de l'Institution des Sourds-Muets.

Après la formation du centre français de Québec et l'existence du centre anglais de Montréal, il veut doter Montréal de son centre français. Toujours animé par le feu sacré de l'astronomie, il remédie à cet état de chose en dotant Montréal de son centre français, le 7 mai 1947, avec l'aide de quelques collaborateurs.

A la demande de la Commission Scolaire et du Conseil de Ville Lasalle, il organise la même année avec l'aide de quelques membres du centre français de Montréal du R.A.S.C., une soirée astronomique publique qui remporte un succès.

Toujours à l'affût d'une idée nouvelle pour inciter les nôtres à s'intéresser aux sciences naturelles, il organise, le 11 février 1950, le premier congrès des géologues amateurs de la région de Montréal. Le 25 mai de la même année il organise une soirée astronomique publique au jardin Botanique de Montréal pour couronner les cours d'astronomie du frère Robert, f.é.c.

Ses observations

Depuis 1910, il s'est plu à observer les aurores boréales, les étoiles filantes, les éclipses de soleil et de lune ainsi que les taches solaires. Les principales planètes qui ont fait l'objet de ses observations sont: Vénus, Mars, Jupiter et Saturne. Son instrument de travail est une lunette Lancaster de 3X. Toujours conscient de l'utilité du travail de l'amateur pour la science, il a toujours transmis ses observations à la Société Astronomique de France, au Royal Astronomical Society of Canada à Toronto et à l'Université Harvard à Cambridge, E.U.

Sa bibliothèque

Jusqu'en 1940, M. J.-E. Guimont avait réussi à se monter une bibliothèque personnelle d'au-delà de 3,000 volumes sans compter les publications, les journaux, les pamphlets, etc. A ce moment, elle comptait des volumes dans presque toutes les sphères du savoir pour assouvir cette soif de connaître qui l'a toujours caractérisé.

En plus il a compilé toutes ses observations, faites de 1910 à date, accompagnées de croquis ou de dessins lesquelles marchent simultanément avec ses mémoires qu'il a réussi à écrire malgré une vie remplie au possible. Il conserve aussi jalousement toute sa correspondance scientifique depuis 1910 qu'il relie toujours avec un plaisir renouvelé.

A partir de 1916 jusqu'à nos jours, toutes ses expéditions scientifiques, ses reconnaissances géologiques et ses voyages sont écrits sous forme de récits de voyage et restent une preuve tangible de son activité fébrile.

Pour occuper le peu de répit que pouvaient lui laisser ses activités si nombreuses et si variées, il s'est constitué une encyclopédie universelle comprenant au-delà de 30,000 articles pris dans les journaux, les revues et classées de A à Z. Simultanément, il a aussi monté une encyclopédie astronomique comprenant plus de 500 chemises aussi classées de A à Z.

Ses adhésions

Monsieur J.-E. Guimont est membre perpétuel de la Société Astronomique de France; membre des centres français et anglais du Royal Astronomical Society of Canada de Montréal; membre de la Société de Géographie de Montréal; membre à vie de la Société Canadienne d'Histoire Naturelle; membre-fondateur de "Les Amis de la Nature", C. N. A.

Après l'évocation d'une vie si pleine d'activités, ne serait-il pas à propos que chacun de nous jette un regard rétrospectif sur sa contribution personnelle au mouvement scientifique au Canada français. Un très grand nombre des nôtres ont deploré et déplorent encore le si petit nombre de vocations scientifiques chez les canadiens-français. Continuellement, Monsieur J.-E. Guimont s'est fait un devoir d'éveiller les nôtres devant cette situation en multipliant les mouvements, spécialement en astronomie et en géologie. Nombre de fois ne s'est-il pas élevé contre l'apathie des nôtres devant l'expansion de notre province surtout dans le domaine minier. Devons-nous encore laisser les étrangers prendre les postes de commande dans ce développement? Quand verrons-nous nos jeunes s'intéresser davantage à nos richesses naturelles pour s'en faire une carrière?

Toujours sur la brèche, notre récipiendaire ne s'est jamais départi de la mission qu'il s'est donnée de faire connaître et aimer notre nature canadienne si belle et si riche qu'elle fait l'envie des étrangers. Par ses articles et ses causeries, il s'est toujours évertué à faire naître chez ses compatriotes le désir de connaître.

En appréciation de son magnifique travail de vulgarisation scientifique, la Fondation Marie-Victorin l'honore d'une de ses décorations. Nous nous joignons à tous les naturalistes pour y ajouter nos plus sincères félicitations.

ABSORPTION OF 10.7-CENTIMETRE SOLAR RADIATION DURING FLARE OF MAY 19, 1951

A. E. Covington* and Helen W. Dodson†

Sudden increases in the emission of radio waves from the sun occur frequently and many of these can be associated with the occurrence of solar flares. As yet no temporary diminution of radio waves has been reported and any evidence relating to this type of phenomenon will be of exceptional interest. Such a diminution of solar radio noise at a wavelength of 10.7 centimetres was recorded on May 19, 1951 at the Solar Radio Astronomy Observatory of the National Research Council in Ottawa, and occurred a few minutes after a typical burst of radiation had been observed at 19^h52^m U.T. (see figure 1). The uniqueness of the event was recognized just after it had occurred and resulted in a special check of the operation of the equipment by A. E. Covington, and the making of an additional calibration of the daily level. This check and calibration indicated that the instrument was working satisfactorily. However, the significance of this unusual feature was not fully appreciated until it was re-discovered in the record files by Helen W. Dodson and E. Ruth Hedeman during a recent visit to the Radio Observatory.

During the morning of May 19, 1951 the steady radio emission from the sun was measured at 13^h35^m U.T. and produced an equivalent temperature of the radiation resistance of the antenna of 500°K. This is equal to 2.15 flux units where one flux unit is 10^{-20} watts/m.^{2} cycle/sec. bandwidth. The flux as measured in the afternoon at 22^h50^m U.T. was 2.17 units. The difference in these two values is only slightly more than the scatter to be expected in making independent calibrations, and has little significance. The emissive part of the burst of radio noise shows typical variations that have been observed frequently in similar bursts recorded in the past[1]; both the intensity of the burst, 2.3 flux units, and the duration, 16 minutes, are average. The absorption of radio waves might be considered to start at 20^h12^m U.T., to reach a maximum depression of 0.17 flux units at 20^h30^m U.T., and to be over by 21^h15^m U.T.

The depression is only a small fraction of the steady daily level, 0.8 per cent., and may be interpreted as representing the temporary removal of an emissive region. The daily level of the radio noise at 10.7 centimetres consists of two parts; one component originating from the inactive solar disk which has a constant intensity for long periods of time, and a second

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†The McMath-Hulbert Observatory of the University of Michigan, Pontiac.

component from the vicinity of sun-spots and *plage* areas which has an intensity related to the sun-spot area (correlative coefficient: 0.95). For this particular day and year, the quiet sun emission was 34 per cent. of the daily level. The 8 per cent. observed diminution in flux can therefore be considered to constitute a reduction of 12 per cent. in the radiation associated with the sun-spot regions.

Intercomparison of radio and photographic observations of the sun for May 19, 1951 indicates that this unusual decrease of radio emission took place during the post-maximum phase of an equally unusual solar flare which was observed and studied at the McMath-Hulbert Observa-

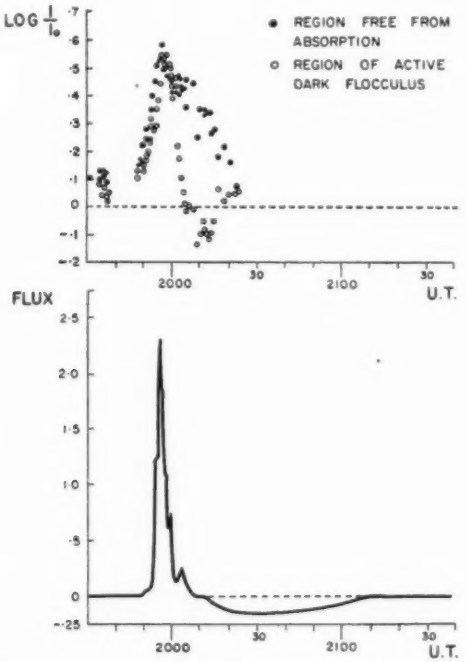


FIG. 1–May 19, 1951. *Upper diagram*: Photometric light curves, Hα flare. *Lower diagram:* 10.7-cm. radio emission.

tory.[2] The flare was judged to be of importance 3–, covered 1350 millionths of the solar hemisphere, and was 3.5 times as bright as the undisturbed Hα disk (1.25 times as bright as the neighbouring continuous

spectrum). All flares of importance are in a sense unusual solar events, but this flare on May 19 was exceptional because of the extent and location of the active dark flocculus that developed just after Hα maximum had been attained. The dark flocculus (prominence material observed in projection against the disk) was at least 125,000 km. in extent and part of it lay directly over the flare. Figure 1 shows the photometric light curve for a part of the flare apparently free from absorption and a second curve for a region in the flare where the intensity was greatly modified by the overlying material. This latter region faded rapidly from flare maximum and for a short time was darker than the undisturbed Hα disk. The Hα absorption became apparent as early as 20^h02^m U.T. Photographic observations were stopped at 20^h25^m, but the dark flocculus was still visible at that time. The flare and active dark flocculus here described are shown in figures 2 and 3.

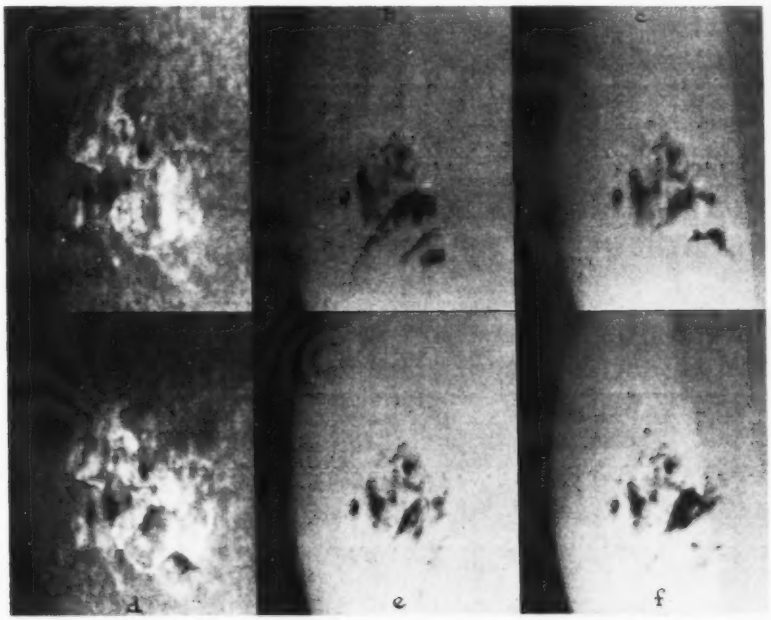


FIG. 2–May 19, 1951. Spectroheliograms showing flare and associated dark flocculus. (a) 19^h56^m; centre of Hα; (b) 20^h08^m; 2A. to violet of Hα; (c) 20^h08^m; 2A. to red of Hα; (d) 20^h06^m; centre of Hα; (e) 20^h19^m; 2A. to violet of Hα; (f) 20^h19^m; 2A. to red of Hα.

(Courtesy, *The Astrophysical Journal*, vol. 115, p. 320, 1952.)

It was during the course of this flare and active dark flocculus that Mohler[3] found the unprecedented twenty-fold increase in the equivalent width of the infra-red helium absorption line, 10830A. The unusual helium absorption was recorded at 20^h06^m and 20^h09^m U.T.

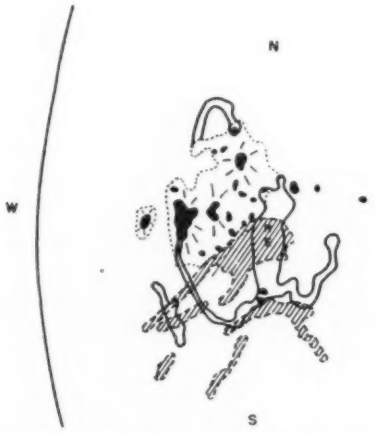


FIG. 3—May 19, 1951. Composite diagram showing spot group, flare *(full outline)*, active dark flocculus *(shaded)*. *E* indicates apparent region from which material was ejected; *H* indicates position of spectrograph slit for helium observations by Mohler.
(Courtesy, *The Astrophysical Journal*, vol. 115, p. 320, 1952.)

The occurrence of active dark flocculi in the post-maximum phase of $H\alpha$ flares is a well established and usual phenomenon. The mere existence of the flocculus is evidently not sufficient to introduce a distinct diminution of flux in the 10.7-centimetre solar radiation.

For example, a flare of importance 2+ occurred on May 18, 1951 near the same spot group as the flare of May 19 just described. This earlier flare was also accompanied during the post-maximum period by a large active dark flocculus at least 120,000 km. in length. The 10.7-centimetre solar radiation for this period shows a burst with the typical post-burst increase but no evidence of absorption. (See figure 4.)

Detailed comparison of the photographic records of the temporary, active dark flocculi accompanying these two flares brings out the following similarities and differences:

1. The dark flocculi on the two dates were comparable in extent.
2. The velocities were of the order of $\pm$ 100 km./sec. on May 18, and $\pm$ 180 km./sec. on May 19.

3. On May 18 the dark flocculus was not superposed on any part of the flare and lay principally outside the large, stable bright *plage* region that surrounded the spots. On May 19 the dark flocculus covered part of the flare and lay principally over the bright *plage*.

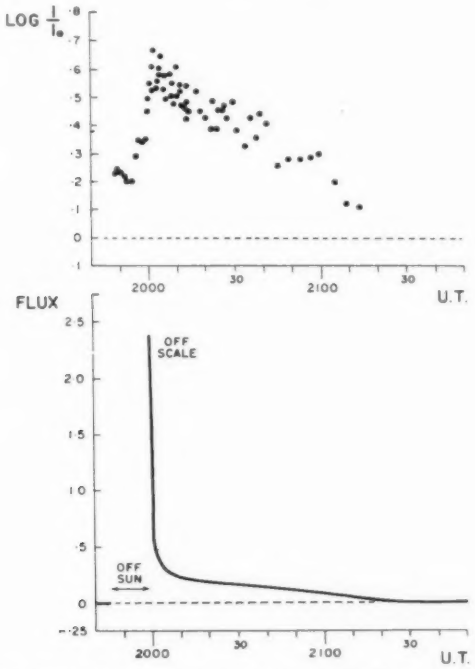


FIG. 4–May 18, 1951. *Upper diagram:* Photometric light curve, Hα flare. *Lower diagram:* 10.7-cm. radio emission.

4. In neither case did the dark flocculus appear superposed over the spots themselves.

The possibility of a reduction or modification in the flux of 10.7-centimetre solar radiation by overlying prominence material, as here suggested, must be borne in mind in further studies of 10.7-centimetre data.

REFERENCES

1. *Jour. Roy. Astro. Soc. Can.*, vol. 45, p. 15, 1951.
2. *Astrophysical Journal*, vol. 115, p. 320, 1952.
3. *Astrophysical Journal*, vol. 115, p. 323, 1952.

REVIEW OF PUBLICATIONS

L'expansion de l'univers by Paul Couderc. (Nouvelle collection scientifique). Pages 222; 5½ x 7½ in. Paris, Presses universitaires de France, 1950.

The Expansion of the Universe by Paul Couderc, translated by J. B. Sidgwick. Pages 232; 5½ x 8½ in. London, Faber and Faber Limited, 1952. Price $6.00.

Many books have been published on the theory of relativity and its cosmological applications. These are either too theoretical for the layman, or too popular, not going beyond a general description of modern cosmologies. The present book by Couderc is a fortunate combination of both, a treatment of the expansion of the universe explaining the meaning of mathematical equations and drawing conclusions from them.

Couderc's book contains nine chapters along with a foreword and two appendices. The first three chapters deal with the observable universe proceeding from our galaxy to the systems at the limit of the 200-inch telescope. It is explained how astronomers measure distances in the space, how they get around the problem of light absorption and how the fact of recession of galaxies is recognized.

Chapter IV states the non-euclidean character of the universe and the concepts of the general theory of relativity. The following three chapters deal with cosmological problems describing the three well-known states of universe, those of Einstein, de Sitter and Lemaître. Couderc accepts Lemaître's view on the original universe, a universe in a hyperdense state, which exploded a couple thousand million years ago and has kept expanding until the present. In chapter VIII the author links different astronomical facts with the evidence of an earlier explosion of this hyperdense universe. Conclusions are drawn in the last chapter. In appendix I recent cosmologies of Milne, Hoyle and Jordan are discussed. Appendix II gives a table of astronomical constants and their numerical values. The book is illustrated with a number of diagrams and photographs.

One can only recommend this book to a reader who is interested in modern problems in astronomy. He will find the book as exciting as a detective story. It speaks well for the success of Couderc's work that it was translated into English almost immediately. The English translation by J. B. Sidgwick, F.R.A.S., is excellent.

G. A. B.

VARIABLE STAR NOTES

American Association of Variable Star Observers

By MARGARET W. MAYALL, *Recorder*

RR Carinae 095458.

A brief report on two variables studied under a grant from the Office of Naval Research was given in the July-August number of these Notes. Another variable on the programme was RR Carinae. Figure 1 is a plot of the 10-day mean values of visual observations of RR Carinae from 1917 to the present time. The first seven years of observation, to J.D. 2423500, were made by J. F. Skjellerup and Arthur W. Long,

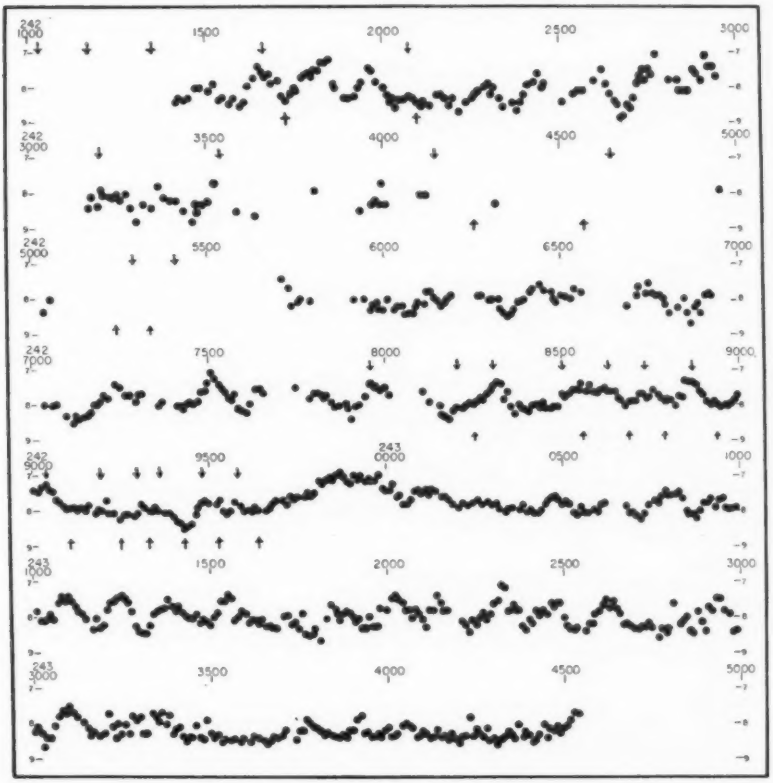


FIG. 1—RR Carinae, 095458.

observers in South Africa. Later observations were made by other members of the A.A.V.S.O. The arrows pointing to the curve indicate the times of maxima and minima determined by C. P. Gaposchkin (*Harv. Annals*, vol. 115, p. 93).

Observations received during June and July, 1953: In June 4,947 observations were contributed, and in July 4,660, making a total of 9,607 received from the following 75 observers.

Observer	June No. Var.	June No. Ests.	July No. Var.	July No. Ests.	Observer	June No. Var.	June No. Ests.	July No. Var.	July No. Ests.
Adams, Robert M.	59	157	53	179	Hartmann, Ferdinand	90	94	115	118
Alvarez, Hector	—	—	8	19	Howarth, Mark	—	—	15	15
Ancarani, Mario	18	20	25	40	Howell, Shapleigh W.	—	—	8	8
Anderer, Joseph A.	16	16	7	7	Johnsson, Robert G.	—	—	5	5
Anderson, Curtis E.	113	312	102	270	Kelley, Leo A.	14	15	13	22
Archer, S.	1	3	—	—	Kelly, Frank J.	11	11	10	10
Aronowitz, Charles	—	—	6	9	Kent	—	—	3	3
Ball, A. R.	—	—	5	5	de Kock, Reginald P.	130	410	136	564
Behar, Alfred	—	—	1	6	Kuenzi, Edward W.	7	34	13	60
Beidler, Herbert B.	18	52	15	33	Lacchini, Giovanni B.	—	—	16	16
Bicknell, R. H.	14	112	20	177	Lofberg, Alan	—	—	1	1
Blunck, Victor H.	—	—	4	8	Miller, William A.	10	16	24	37
Bonilla, Tony	6	8	—	—	Montague, Allen C.	37	82	43	87
Botham, John H.	12	32	22	24	Neff, John	—	—	34	37
Boutell, Hugh G.	6	35	7	29	Newing, James	—	—	3	3
Buckstaff, Ralph N.	28	65	21	65	Oravec, Edward G.	66	159	77	331
Chapman, Gary	—	—	4	4	O'Sullivan, Wm. H.	10	12	6	11
Charles, Donald F.	8	13	—	—	Overbeek, Michiel D.	77	173	81	174
Chester, Bryant	10	10	7	7	Parker, P. O.	39	39	40	40
Cragg, Thomas A.	144	153	141	144	Parko, Joseph E., Jr.	—	—	3	3
Dafter, Rosina	9	45	—	—	Pearcy, Robert E.	7	7	—	—
Darsenius, Gunnar O.	50	104	3	4	Peltier, Leslie C.	31	119	47	173
Diedrich, DeLorne	2	4	2	6	Peter, Hermann	43	749	—	—
Diedrich, George	3	8	3	14	Renner, Carl J.	—	—	208	380
Elias, Demetrius P.	96	1158	71	479	Rick, Louis	1	1	—	—
Estremadoyro, Gustavo A.	4	4	—	—	Rizzo, P. V.	15	47	15	72
Estremadoyro, Victor A.	6	6	—	—	Rosebrugh, David W.	16	45	12	67
Fernald, Cyrus F.	149	256	161	261	Ruiz, John J.	—	—	1	129
Ficonetti, Rene	21	30	—	—	Semos, Elias B.	—	—	1	5
Fink, Richard R.	—	—	3	3	Sevener, Clyde C.	—	—	3	3
Ford, Clinton B.	11	11	104	116	Smits, Peter	13	24	11	35
Galbraith, William H.	37	72	—	—	Spooner, John M.	—	—	3	16
Gaustad, John	9	12	10	14	Stryzewski, Eugene	—	—	2	2
Greenley, Robert M.	39	39	34	35	Taboada, Domingo	7	7	26	26
Haberstroh, Robt. A.	—	—	4	4	Thomas, Morgan	—	—	2	4
Halbach, Edward A.	—	—	68	74	Venter, S. C.	80	113	72	108
Hales, LaVaughn	—	—	5	7	Welker, Frank	23	23	—	—
					Wyckoff, Jerome	26	30	28	52

Observations of long period variables at minimum. When we glance over the plots of the light curves of the variables on the A.A.V.S.O. list, we see that many of the stars are well observed when they are bright, but sadly neglected when they are faint. This is due partly to the large number of observers with small instruments, but is also due somewhat to the fact that many observers do not make the fullest use of their equipment—perhaps it is much easier and quicker to find and estimate the magnitude of a fairly bright star than it is to do a faint one! The following list of variables gives the approximate number of days around the predicted miminum during which we need more observations. Most of the magnitudes will be 13 and fainter.

Variable		No. Days	Variable		No. Days	Variable		No. Days
001838	R And	100	103769	R UMa	100	191124	TY Sgr	150
001909	S Cet	100	104628	RS Hya	100	191319a	S Sgr	100
003179	Y Cep	150	110506	S Leo	100	191321	Z Sgr	200
004132	RW And	150	111561	RY Car	200	191331	SW Sgr	100
004435	V And	100	115919	R Com	100	192928	TY Cyg	150
004435	X Scl	100	120905	T Vir	200	194604	X Aql	200
004533	RR And	100	130212	RV Vir	100	195202	RR Aql	150
004746a	RV Cas	150	134536	RX Cen	100	195308	RS Aql	200
010630	U Scl	200	135908	RR Vir	100	200357	S Cyg	100
010940	U And	100	140512	Z Vir	150	200514	R Cap	100
011041	UZ And	200	142205	RS Vir	100	200747	R Tel	200
011208	S Psc	200	143417	V Lib	100	200812	RU Aql	100
012502	R Psc	100	145254	Y Lup	100	201130	SX Cyg	100
015912	S Ari	150	150519	T Lib	100	202240	U Mic	100
021281	Z Cep	200	150605	Y Lib	100	202817	Z Del	100
022980	RR Cep	200	153215	W Lib	100	203611	Y Del	200
030514	U Ari	200	153620a	U Lib	100	203905	Y Aqr	100
034625	U Eri	100	154615	R Ser	100	204104	W Aqr	100
040725	W Eri	100	154715	R Lib	100	204215	U Cap	100
042209	R Tau	150	160021	Z Sco	100	204318	V Del	200
042309	S Tau	200	160519	W Sco	100	204954	S Ind	200
050848	S Pic	150	161122b	S Sco	100	205017	X Del	100
054615a	Z Tau	200	162319	Y Sco	150	205030a	UX Cyg	200
054974	V Cam	200	162815	T Oph	200	210221	X Cap	100
065111	Y Mon	100	164319	RR Oph	100	210382	X Cep	200
070109	V CMi	100	165202	SS Oph	100	210504	RS Aqr	100
071201	RR Mon	200	165636	RT Sco	200	215605	V Peg	100
072820b	Z Pup	300	170833	RW Sco	150	215934	RT Peg	100
073508	U CMi	200	171401	Z Oph	100	220133b	RZ Peg	200
075612	U Pup	200	174135	SV Sco	100	220412	T Peg	100
082476	R Cha	100	174162	W Pav	100	221321	X Aqr	150
084803	S Hya	100	175111	RT Oph	200	221948	S Gru	100
085008	T Hya	100	181031	TV Her	100	222867	R Ind	100
090425	W Cnc	150	182224	SV Her	100	223841	R Lac	100
091868	RW Car	150	182306	T Ser	150	225120	S Aqr	100
093178	Y Dra	100	183149	SV Dra	100	225542	SZ And	150
094023	RR Hya	100	184134	RY Lyr	100	235209	V Cet	100
094953	Z Vel	100	185032	RX Lyr	100	235265	R Tuc	100
095563	RV Car	200	185512a	ST Sgr	100	235525	Z Peg	150
101058a	Z Car	200	185634	Z Lyr	100	235715	W Cet	150
101058b	AF Car	300	185737	RT Lyr	100	235855	Y Cas	200
102900	S Sex	100	190925	S Lyr	150			
103270	RZ Car	150	191007	W Aql	200			

Nova Search Programme: During the months of June and July, reports were received from eight observers, as follows. Listed for each observer is the month of observation, the areas observed (in italics), the number of nights the region was checked, and finally, the limiting magnitude.

BLUNCK, VICTOR H., July–*8, 9, 10:* 4, 6.
DARSENIUS, GUNNAR O., June–*Dome:* 1, 2; *16, 17:* 3, 5; *16, 17:* 1, 6; July–*16, 17:* 1, 6.
*DIEDRICH, DELORNE, June–*Dome:* 1, 2; *94:* 2, 6; July–*Dome:* 2, 2; *94:* 3, 6.
*DIEDRICH, GEORGE, June–*Dome:* 3, 2; *56:* 2, 6; *78:* 3, 6; July–*Dome:* 6, 2; *56:* 1, 6; *56:* 1, 5; *78:* 6, 6.
*RICK, J. J., July–*78:* 2, 4.
*RICK, LOUIS, June–*Dome:* 2, 1; *Dome:* 2, 2; *18:* 1, 3; *63:* 1, 3; July–*Dome:* 8, 2; *Dome:* 1, 1; *18:* 2, 3; *63:* 1, 5; *63:* 5, 4.
ROSEBRUGH, DAVID W., June–*Dome:* 6, 3; July–*Dome:* 7, 3; *1:* 2, 4.
SMITH, FRANKLIN W., June–*3, 4:* 1, 6; July–*3, 4:* 1, 6.
*Black River Astronomical Society.

Harvard College Observatory
Cambridge 38, Massachusetts
July 27, 1953

METEOR NEWS

By Peter M. Millman, *Dominion Observatory, Ottawa*

Photographic Meteor Spectra (Appendix 1)

In the interests of correlating and systematizing scientific data secured from photographic meteor spectra a comprehensive list of these was published in the Journal last year, vol. 46, p. 121, 1952. Additional information concerning some of the 1950 spectra have since been received, and a number of additional meteor spectra were photographed in 1951 and 1952. These data have been summarized below in an appendix to the original list.

LIST OF PHOTOGRAPHIC METEOR SPECTRA (APPENDIX 1)

No.	Date			G.C.T.			Shower	Location (Observatory)	Ref.
	y	m	d	h	m	s			
109	1950	8	9	23	17	54	P	Simferopol, U.S.S.R. (V.A.G.O.)	20,22
118		8	12	5	21		P	Blairsden, Calif. (U.S.C.)	
119		8	12	10	04	*	P	Blairsden, Calif. (U.S.C.)	
120		8	12	11	03	*	P	Blairsden, Calif. (U.S.C.)	
121		8	13	9	05	*	P	Blairsden, Calif. (U.S.C.)	
122		8	13	12	04	*	P	Blairsden, Calif. (U.S.C.)	
123	1951	8	12				P	Odessa Ast. Obs., U.S.S.R.	23
124		8	13	9	18	*	P	Blairsden, Calif. (U.S.C.)	
125	1952	8	13	4	33	18	P	Metcalfe Rd., Ont. (D.O.)	
126		8	13	7	52	44	P	Meanook, Alta. (D.O.)	
127		8	14					Simferopol, U.S.S.R. (V.A.G.O.)	24
128		8	14	6	02	25	P	Soledad, N.M. (H.C.O.)	
129		8	15	9		*		Soledad, N.M. (H.C.O.)	
130		8	18					Simferopol, U.S.S.R. (V.A.G.O.)	24
131		8	20	6	35	39		Soledad, N.M. (H.C.O.)	
132		10	20	6	48			Meanook, Alta. (D.O.)	
133		12	12	9	30		G	Meanook, Alta. (D.O.)	

Only brief announcements have appeared concerning the new spectra photographed in Russia. The three Harvard spectra were obtained in New Mexico with small cameras exposed on the general programme of meteor photography involving the use of the new Super-Schmidt meteor cameras. Of the four Dominion Observatory spectra, three were photographed at the Meanook Meteor Observatory where one of the Canadian Super-Schmidts is also in operation. Spectrum No. 126 is the most

detailed secured to date. It was photographed with a new Bausch and Lomb replica grating, 5,000 lines to the inch, and shows a detail of over 100 bright lines.

REFERENCES

22. Bakarev, A. M., *Bul. Stalinabad Ast. Obs.*, no. 2, p. 3, 1952.
23. Kramer, E. N., *Ast. Cir. U.S.S.R.*, no. 119, p. 9, 1951.
24. Liubarskii, K. A. and Snegireva, R. V., *Ast Cir. U.S.S.R.*, no. 131, p. 22, 1952.

MONTREAL PERSEID OBSERVATIONS, 1951 AND 1952

As in previous years an active group from the Montreal Centre of the Society observed the Perseid meteors in 1951 and 1952. The following observers, recorders and timekeepers took part in these observations:

1951. August 10–11—E. E. Bridgen, R. Brodeur, A. L. Burran, W. J. Cullinan, J. W. Duffie, C. M. Good, O. Giroux, F. DeKinder, E. Milton, H. MacCallum, P. S. Scott, R. Venor, W. Warren, Miss I. K. Williamson, Mrs. J. Wright, Mrs. D. Zorgo.

1952. August 13–14—E. E. Brigden, F. DeKinder, D. Garneau, C. M. Good, R. Venor, G. C. Wark, Miss I. K. Williamson, Mrs. J. Wright, Mrs. D. Zorgo.

A tabulation of the numbers of meteors seen will be found in Table I, where the actual numbers observed in each twenty-minute interval are

TABLE I

E.S.T.	1951 August 10/11				1952 August 13/14			
	Perseids		Non-Perseids		Perseids		Non-Perseids	
	No.	H.R.	No.	H.R.	No.	H.R.	No.	H.R.
21.10—21.30					4	24	1	3
—21.50					5	24	0	2
—22.10	2	10	0	2	5	31	0	0
—22.30	2	14	1	3	9	33	0	0
—22.50	7	17	1	3	5	34	0	0
—23.10	6	28	0	1	5	35	0	0
—23.30	13	37	0	0	8	33	0	0
—23.50	15	37	0	1	4	33	0	2
—00.10	6	34	1	4	7	35	1	2
—00.30	12	36	3	5	9	47	0	2
—00.50	18	40	1	4	10	46	0	0
—01.10	9	42	0	2	5	43	0	0
—01.30	11	40	1	2				
—01.50	16	49	1	2				
—02.10	18	49	0	1				
—02.30	12	47	0	0				
—02.50	13	36	0	0				
02.50—03.10	5	34	0	0				
Totals	165		9		76		2	

listed under "No." and the hourly rates reduced to six observers plotting under "H.R." An average of 5 observers, exclusive of recorder and time-keeper, were on duty all the time during both programmes. In 1951 there were some light clouds during the first half hour, clear later. In 1952 the sky was partially cloudy from 2220 to 2300 hrs. It will be noted that the standard Perseid rates were very nearly the same for the two nights, reaching almost 50 meteors per hour.

The observed magnitude distributions are listed in Table II. As is usually the case the mean magnitude of the Perseids was brighter than that for the Non-Perseids.

TABLE II

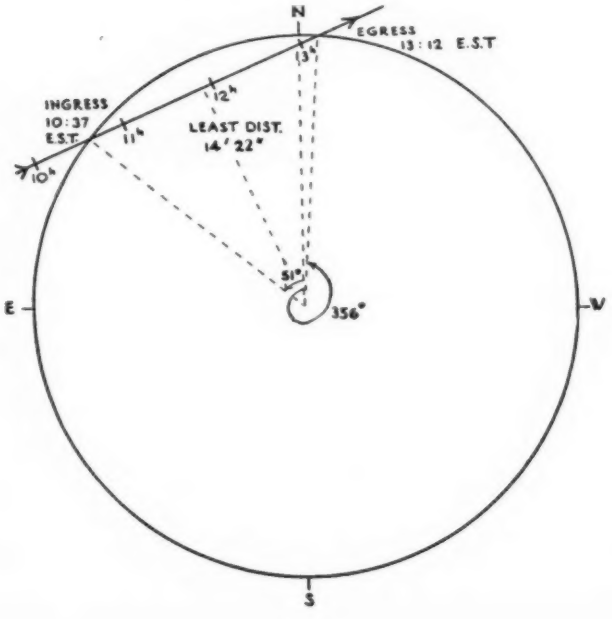
Mag.	−2	−1	0	1	2	3	4	5	Totals	Mean Mag.
1951										
P	1	5	8	36	47	42	21	4	164	2.15
N				1	3	3	2		9	2.67
1952										
P		3	1	8	25	28	8	3	76	2.44
N					1		1		2	3.00

We will be looking forward to more meteor observations from our Montreal members.

NOTES AND QUERIES

Transit of Mercury, November 14, 1953

Mercury is one of the two planets which sometimes pass between the earth and the sun. The orbit of Mercury is inclined to the plane of the ecliptic by an angle of about seven degrees. Because of this, at inferior conjunction when Mercury is between the earth and the sun, Mercury usually passes either north or south of the sun's disk and is invisible. However, when inferior conjunction occurs at a time when Mercury is near one of its nodes, the little planet transits or crosses the sun's disk. The earth passes the nodes on May 8 and November 10, so that only when inferior conjunction occurs within several days of these dates can a transit of Mercury occur. There are only about a dozen transits of Mercury a century. Transits of Venus, the other inferior planet, are even less frequent; the last pair took place in 1874 and 1882, the next ones are



due in 2004 and 2012. The last transit of Mercury occurred November 11, 1940. Transits of Mercury are invisible without a telescope.

The transit of Mercury of November 14, 1953 is visible from all North America except the north-western part. All across Canada, the times of ingress and egress are the same within a fraction of a minute, namely $10^h\ 37^m$ and $13^h\ 12^m$ E.S.T. The position angles of ingress and egress are 51° and 356° respectively. The diagram shows the path of Mercury as it transits the sun's disk. The directions are as seen in the sky; observers should take care to turn the diagram to represent the field of their instruments. The horizon cannot be indicated because of the interval of over two hours and the large range of longitude in Canada. The direction from the centre of the sun to *N* in the diagram must be in line with the sun and the north celestial pole in the sky.

Observations of the times of ingress and egress are of importance in determining the elements of Mercury's orbit and in checking irregularities in the earth's period of rotation. Bad seeing may cause uncertainty in the observed times which can be remedied only by having *many* observations. It is necessary to know the time to within one or two seconds; this is possible with modern radio time signals. We would urge that all members with telescopes plan to observe this transit, and submit their observations to the David Dunlap Observatory. It has been said that "The results of previous transits have always suffered from the too small number of observations obtained."

R. J. N.

Symposium at University of Michigan

A symposium on astrophysics was held from June 29 to July 24 at the University of Michigan with the following lecturers:

Dr. Walter Baade, Mount Wilson and Palomar Observatories, "Galaxies: Their Composition and Structure", 12 lectures.

Dr. George Gamow, George Washington University, "Evolution of Stars and Galaxies", 6 lectures.

Dr. Gerard P. Kuiper, University of Chicago and Yerkes and McDonald Observatories, "The Origin of the Solar System", 4 lectures.

Dr. G. K. Batchelor, University of Cambridge, "Turbulence in Stars and Nebulae", 6 lectures.

Dr. E. E. Salpeter, Cornell University, "Nuclear Transformations and Stellar Energy Generation", 6 lectures.

In addition, Dr. Allan Sandage, Dr. Harold C. Urey, Dr. Donald Osterbrock, Dr. Geoffrey Keller and Dr. Nancy Roman gave single lectures

on special topics. Over fifty astronomers (including graduate students) participated, and others were also able to attend for a day or two. A number were aided to attend by the National Science Foundation.

In the symposium lectures emphasis was placed on the discussion of current problems in the structure and evolution of stars, of galaxies and of our solar system. Many questions were asked, and a few special problems may even have been solved!

Other interesting events at the symposium included a visit to the McMath-Hulbert Observatory at Lake Angelus, followed by a picnic at Miss Dodson's home on the shore of Lake Angelus and several picnics and beach parties at nearby lakes. Several visitors were able to find time also to do some research work with Michigan plates and equipment.

The informal atmosphere pervading the symposium (because of the warm weather one of the speakers delivered most of his lectures in shorts) and the many informal discussions will most certainly have some influence on the direction of research to be pursued by several observatories. It was most stimulating to see how great had been the advances in astrophysics during the three years since the previous symposium held at Michigan as part of the dedication ceremonies of the Heber D. Curtis Schmidt telescope. Let us hope that another symposium of this nature may be held again after a similar interval of time.

All of those so fortunate as to have been able to attend all or part of the symposium owe Dr. Goldberg, Mrs. Weddell and the other members of the Michigan Astronomy Department a vote of thanks for making their visits to Ann Arbor so profitable and enjoyable.

E. B. W.

Night Vision

Many astronomers, and particularly amateurs, may have been hampered in their work by not being able to see charts or faint stars for some time after leaving a bright room. During the last war, armed services personnel solved this kind of problem by wearing red goggles for 30 minutes before they needed their eyes for night vision. Recent experiments reported to the *Journal of the Optical Society of America* (June) by Dr. Walter R. Miles of the Psychological Laboratories, Yale University, show that remaining in complete darkness for 30 minutes is even better than using red goggles, particularly for the first few minutes in which the eyes are required for night vision.

J. B. O.

NOTES FROM OBSERVATORIES

David Dunlap Observatory

Frank S. Hogg Memorial Fellowship. Announcement has been made by the School of Graduate Studies of the University of Toronto of the first award of the Frank S. Hogg Memorial Fellowship in astronomy to Gustav Bakos for the 1953–54 session. This fellowship was established by contributions of many friends and admirers of Dr. Frank Hogg, late Director of the David Dunlap Observatory. The fund has passed the $8500 mark and now provides an award of $600 every other year. The first recipient, Mr. Bakos, has been a graduate student in the Department of Astronomy for one year already, and he will be enabled by the award to carry on for a second year. He received his early training in astronomy in his native country of Czecko Slovakia and he has also studied at Leiden Observatory in Holland. He is engaged in the study of eclipsing variables, and appropriately enough, he is presently studying plates taken by Dr. Frank Hogg in 1936.

The Fellowship Committee takes this opportunity again to thank those whose contributions have led to the establishment of the fellowship.

Staff. Dr. Ralph E. Williamson has resigned from his position as Associate Professor of Astronomy and has returned to the United States where he is at present engaged in defence work. Dr. Williamson's excellent work here during the past seven years as a teacher and as a research worker in the fields of astrophysics and radio astronomy will long be remembered. His colleagues at the Observatory and his friends in the Society wish him every success in his new work.

Dr. Donald A. MacRae of the Warner and Swasey Observatory at Cleveland has been appointed to the staff of the David Dunlap Observatory as Associate Professor of Astronomy. Dr. MacRae is a 1937 graduate of the University of Toronto and received his Ph.D. from Harvard University. During the session 1937–38 Dr. MacRae was an assistant at this Observatory, and his friends here welcome his return after the intervening years of success in astronomy elsewhere.

New appointments to the staff as lecturers in astronomy are Dr. J. B. Oke and Dr. W. R. Hossack. Dr. Oke, who graduated from the University of Toronto in 1949 and received his M.A. in 1950, has recently been awarded a Ph.D. by Princeton University. Dr. Hossack graduated from

the University of Toronto in 1948 and received his M.A. in 1949 and his Ph.D. in 1953.

Dr. Peter Wellmann of Hamburg Observatory, Germany, has been Visiting Professor of Astronomy at the Observatory between May and October. Dr. Wellmann has been collaborating with members of the staff in problems of common interest at the David Dunlap and Hamburg Observatories.

Summer assistants at the Observatory have included Miss Sally Hogg, recently graduated from the University of Toronto, and Mr. Donald Morton, a student at the University.

Professor Helen Hogg, Mr. E. B. Weston, Dr. Peter Wellmann and Dr. J. B. Oke attended some of the sessions of the Symposium on Astrophysics held this summer at the University of Michigan. Dr. Wellmann and Mr. Weston also attended the meeting of the American Astronomical Society at Boulder, Colorado, in August, where they presented papers by members of the Observatory staff.

Bausch & Lomb BALscope, Sr. is a highly precise, compact 60mm telescope. A deserved favorite for beginning astronomers, it also serves the advanced field as an adequate commercial version of a richest field telescope. Choice of four eyepiece powers as listed below. (With any of the three lower-power eyepieces, BALscope, Sr. is also an outstanding general observation terrestrial telescope.)

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